URBAN WILDLAND INTERFACE BUILDING TEST STANDARDS
12-7A-3
Fire Resistive Standards for EAVES

STATE FIRE MARSHAL

(a) ***Application.*** *The minimum design, construction and performance standards set forth herein for exterior wall eaves are those deemed necessary to establish conformance to the provisions of these regulations. Materials and assemblies that meet the performance criteria of this standard are acceptable for use in Very High Fire Hazard Zones as defined in California Building Code, Chapter 7A.*

(b) ***Scope.*** *This standard determines the performance of eaves of exterior walls of structures when exposed to direct flames.*

(c) ***Referenced documents.***

1. *ASTM D4444. Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters*
2. *California Building Code, Chapter 7A.*

(d) ***Definitions***

1. ***Eaves.*** *A projecting edge of a roof that extends beyond the supporting wall.*
2. ***Soffit.*** *The enclosed underside of any exterior overhanging section of a roof eave.*

(e) Equipment

1. ***Burner.*** *A 4 x 39 in. (100 x 1000 mm) propane diffusion burner shall be used.*
2. ***Infrared temperature analyzer*** *(optional). Intended for monitoring the temperature change of the inside of the eaves.*
3. ***Moisture meter.*** *For measurement of moisture content of framing (see ASTM D4444).*

(f) ***Materials***

1. ***Framing.*** *The materials used shall be representative of the grades that would be typical of eave construction and installed in the eaves subassembly as per accepted construction practices.*
2. ***Soffit****. Material selected for the test.*

(g) ***Test system preparation (Figure 1)***

1. ***Eaves fabrication****. The assembly shall be constructed to fit into a 4-ft- (1.2-m-) wide space in the wall module. Normal roof framing, joints in soffit material, and other typical features present in the constructed assembly shall be present in the test specimen.*
2. ***Wall Module.*** *The module shall be designed to permit rapid installation and removal of eave assemblies and have two adjustable non-combustible sidewalls.*
3. ***Eaves assembly****. Fit the eave assembly into the wall module so that the lowest point of the assembly is 82 in. (2.1 m) from the top of the burner.*
4. ***Moisture content****. Measure the moisture content of the wooden members of the assembly using a moisture meter (D4444).*
5. ***Sealing****. Seal the edges and ends with ceramic wool or comparable material to prevent flame penetration in these locations of the eave assembly.*
6. ***Finish****. The eaves shall be finished in a manner appropriate for exterior exposure as per accepted construction practices.*

(h) Conduct of Tests.

1. ***Airflow.*** *The wall test shall be conducted under conditions of ambient airflow.*
2. ***Number of tests****. Conduct the tests on three replicate eaves assemblies .*
3. ***Burner output verification.*** *Without the eaves assembly in place, adjust the burner for 300 ± 15 kW output. Extinguish the burner.*
4. ***Burner configuration****. Center the burner with respect to the width of the eaves-wall assembly and 0.75 in. (20 mm) from the wall. The distance from the floor to the top of the burner shall be 12 in. (300 mm).*
5. ***Procedur****e*
   i) Ignite the burner, controlling for a constant 300 ± 15 kW output.
   ii) Continue the exposure until flame penetration of the eaves occurs or for a 10-min period.
   iii) If penetration does not occur, continue observation for an additional 30 min or until all combustion has ceased. An infrared thermometer has been found to be useful to detect the increase of temperature on the back side of the eaves and as an aid to identify the areas of potential combustion.
6. ***Observations.*** *Note the time, location, and nature of flame penetration.*

(i) ***Report.*** *The report shall include a description of the eaves material, details of the construction of the eaves, moisture content of the framing, and point of flame penetration. Provide details on the time and reasons for early termination of the test.*

(j) ***Conditions of Acceptance.*** *Should one of the three replicates fail to meet the Conditions of Acceptance, three additional tests may be run. All of the additional tests must meet the Conditions of Acceptance.*

1. *Absence of flame penetration of the eaves at any time.*
2. *Absence of structural failure of the eaves subassembly at any time.*
3. *Absence of sustained combustion of any kind at the conclusion of the 40-min test.*

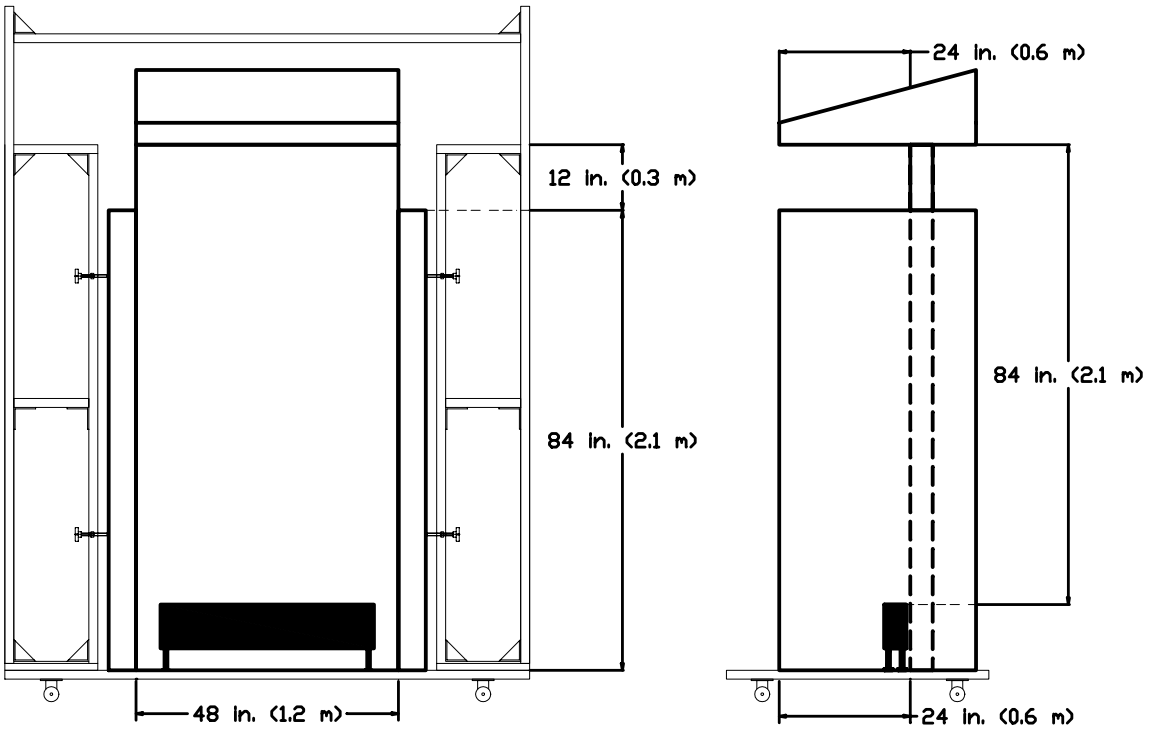

Figure 1. Eaves-Wall Test Assembly

COMMENTARY: EAVES

Purpose. This Commentary is to provide the background and rationale for the Standard. The work that led to this Standard was funded by the California Office of Emergency Services through the Office of the State Fire Marshal, and was provided as FEMA mitigation funds following the 1993 Southern California firestorm. Under the administration of OSFM, the University of California Forest Products Laboratory (UCFPL) developed fire test protocols for Urban-Wildland Interface (UWI) fire in consultation with fire researchers throughout the world and with fire authorities in California.

The research by UCFPL started in 1995; at the completion, after about four years, the work was reviewed by a committee of California fire authorities who prepared a report intended to lead to model building codes. However, the movement to code was delayed until 2004, when the California Legislature (through AB1216) directed OSFM to complete the code work by 1 January 2005. Under the administration of OSFM, the test protocols developed by UCFPL were written into Standards language.

Included in the Commentary are explanations of the development of test protocols and results from the preliminary tests at UCFPL. The tests were not intended to "certify" materials and/or assemblies, but to provide guidance in the development of the test protocols and for the "conditions of acceptance." Also included are discussions of issues that were not addressed in the protocols, but which should be explored to amend the Standards to better address UWI fire issues.

Issues in UWI fire.
Eaves have three concerns of interest:

1. Ignition from combustible siding or other combustibles near the base of a structure, and penetration through the soffit, or unboxed or boxed eaves, or seams in any of these assemblies.

2. Increased risk of fire penetration into the attic or wall assembly at the roof-to-wall interface.

3. Any vents associated with eaves.

Development of the Test Protocol.
Since flaming combustion from ornamental plants (or equivalent combustibles) or from exterior wall cladding is the most probable source of fire exposure, tests were run to simulate exposure from medium-size plants and cladding. In preliminary tests, the decision was to use a 600-kW line burner output until burn-through was indicated.

Tests.

Materials. Two boxed-in eave configurations were tested: a soffit consisting of nominal 1 x 4 tongue-and-groove boards, and 6 mm (0.25 in.) plywood. The boards were a clear grade of Douglas-fir, attached by blind nailing through the tongue of each board into the roof rafter. The plywood was an AC grade, with the "A" face exposed to the flame.

Assemblies. The channelized wall assembly used for the wall and window tests was also used in for these tests, where all vertical members consisted of gypsum wallboard. The soffitted eave assembly was attached to the wall assemble. The outside edges of the soffit materials, at the connections to the wall assembly at the horizontal top plates, were protected with strips of ceramic wool to prevent flame penetration at joints.

Test procedure. For each test a single layer of newspaper was placed directly on top of the soffit material on the inside of the eave assembly to use for visual detection of burn-through.

Results. The two replications of the plywood soffit samples had burn-through at 1:30 and 2:00 min. Failure occurred at an open knot on the unexposed face of replication #1, and through a core gap in replication #2. In both cases, failure occurred within 150 mm (6 in.) of the back wall. The two replications of the Douglas-fir tongue-and-groove soffit failed at approximately 8:00 and 6:00 min. As was the case with the plywood, failure occurred near the back wall at the first or second joint from the wall.

Comments. Although the tests were run at 600 kW, observations during the testing suggested that 300 kW for 10 min would be a reasonable exposure. The length of time is consistent with the 10-min exterior wall and window Standards (SFM-1 and SFM-2). The 300 kW level is double that for the latter standards and is reasonable to account for the heat release of ignitable siding that was noted in preliminary testing of cladding. The limited testing done to date on soffit materials support observations made in tests of other materials: protection of joints is critical, and defects within the field of a material that reduce its effective thickness will adversely affect performance. With combustible soffit materials, joints or product variability would likely be the weak link in the assembly. For most non-combustible soffit materials, such as a fiber-cement product, joints between panels will be the most likely point of failure. Although not directly indicated by the results of these tests, providing adequate fire barrier protection at the eave to exterior wall interface is critical, and should be incorporated in test procedures as well as in "best practices." Vulnerability of vents located in the soffit area must be addressed in a future standard.

Conditions of Acceptance. Based on the tests, the acceptance criteria listed in Standard SFM-3 were considered appropriate